Adjacent Joint Kinematics after Ankle Arthrodesis in Cadaveric Gait Simulation

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Introduction/Purpose: Ankle arthrodesis is an effective treatment for decreasing pain in patients with end-stage ankle arthritis. However, all patients with an ankle arthrodesis will eventually develop adjacent joint arthritis. The etiology of adjacent joint arthritis after ankle arthrodesis is not fully understood due to the difficulty of investigating these joints in vivo. Cadaveric simulation provides a unique capability of studying intrinsic foot and ankle joint mechanics. The objective of this study was to establish the effect of ankle arthrodesis on adjacent joint kinematics using cadaveric gait simulation. We hypothesized that adjacent joint motion of the hindfoot would increase after ankle arthrodesis.

Methods: Four mid-tibia cadaveric specimens were potted and secured to a static mounting fixture about a six-degree of freedom robotic platform. (Figure 1A) The nine extrinsic ankle tendons were isolated and connected to linear actuators instrumented with load cells in series. During simulations, a force plate was moved relative to the stationary specimen through an inverse tibial kinematic path. Three-dimensional ankle and hindfoot kinematics were captured using a motion capture system. After ankle arthrodesis, kinematics were recorded using the same muscle force and kinematic inputs as the intact condition to determine how the hindfoot would behave when simulating normal gait. To assess the effect of ankle arthrodesis during simulated walking on adjacent joint kinematics, pre- and post-arthrodesis kinematics of the subtalar and talonavicular joint were directly compared along the stance phase and differences were assessed using two-tailed, paired Student’s t-tests with an alpha value set at $p = 0.05$.

Results: Subtalar and talonavicular joint plantarflexion was greater during the early phase of stance in the ankle arthrodesis condition. (Figure 1B and 1C). Talonavicular joint motion also demonstrated greater dorsiflexion during late stance following ankle arthrodesis (Figure 1C). Ankle arthrodesis had no detectable effect on axial or coronal plane motion in adjacent joints of the hindfoot.
**Conclusion:** This study reveals that sagittal plane motion in the hindfoot is increased following ankle arthrodesis. These results provide further insight into how motion is redistributed to adjacent joints after arthrodesis during gait. Such compensatory motions may be related to changes in contact mechanics in adjacent joints which can lead to degenerative changes.